

MOVEMENT PATTERNS OF NON-PUP HARBOR SEALS IN THE KODIAK ARCHIPELAGO AND SOUTHEAST ALASKA

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INTRODUCTION

Harbor seals (*Phoca vitulina richardsi*) are a common phocid found throughout the coastal waters of southern Alaska. Counts of harbor seals in the Gulf of Alaska indicate that seal numbers declined by 80-90% from the mid 1970s through the early 1990s (Pitcher 1990, Jemison and Pendleton 2001, Frost *et al.* 1999). More recently, seal numbers increased 5.6% annually in the Kodiak area from 1993-1999 (Small *et al.* 2001), whereas in Prince William Sound numbers continued to decrease 4.6% annually from 1990-1997 (Frost *et al.* 1999). Counts in Southeast Alaska indicate seal numbers have increased or remained stable since the early 1980s (Small *et al.* 2001), although a recent decline in Glacier Bay has been reported (Matthews and Pendleton 2000).

To increase our understanding of the movements, haulout use patterns, and foraging areas of harbor seals we captured and deployed satellite-linked depth recorders (SDRs) on adult and subadult harbor seals during 1993-1997 in both the Kodiak and Southeast Alaska regions. In addition to enhancing our basic biological knowledge of this marine predator in Alaska, information gained during this study will also be applied to current genetic research designed to identify stock boundaries, and to elucidate potential interactions with commercial fisheries. This chapter represents a status report of the analyses completed to date.

METHODS

SDRs were attached to adult (n=43) and subadult (n=20) harbor seals captured in spring prior to the pupping period and in fall after the molting period in Southeast Alaska (n=34) and the Kodiak Archipelago (n=29). Location data were screened by eliminating erroneous records based on an error index value and the time, distance, and speed between sequential pairs of locations. All locations with Service Argos quality ranking ≥ 1 during each haulout bout were averaged and assigned to a specific haulout site, whereas all at-sea locations were used in analyses regardless of quality ranking. The area within the minimum convex polygon (with land area excluded) that

included all locations for each month was considered the monthly ‘foraging area’. A generalized linear model with a logit link function and a binomial distribution was used to determine if seal movement patterns were influenced by age, sex, region, and month.

RESULTS AND DISCUSSION

Movements, haulout use patterns, and ‘foraging area’ size were not statistically different by region (i.e., Southeast vs. Kodiak) or sex, but there were consistent differences between adults and subadults (Fig. 1), and some differences across months. Maximal distance moved between any two haulouts by subadults was more than double that of adults (Table 1), and the mean distance traveled between successive haulouts as well as the size of at-sea foraging areas were also significantly greater for subadults.

Table 1. Movement patterns of adult and subadult harbor seals in the Kodiak Archipelago and Southeast Alaska regions, 1993-1997. All parameters are in kilometers with associated 95% confidence intervals.

	Adults	Subadults	P
Maximal distance between any two haulout sites	14.3 (12.3 - 16.7)	35.8 (22.6 - 56.7)	<0.001
Mean distance to at-sea locations	7.6 (7.0 - 8.1)	9.1 (7.6 - 11.0)	0.056
Mean distance between successive haulout sites	2.7 (2.3 - 3.2)	4.3 (2.9 - 6.4)	0.024
At-sea foraging area size	266.6 (217.4 - 326.8)	384.6 (284.0 - 520.9)	0.028

The monthly cumulative distance traveled among haulouts was similar between adults and subadults, but was significantly different ($P=0.008$) across months. Seals traveled the greatest distances among haulouts in May immediately prior to the pupping period, and traveled the least in July and September (no data available in August) during the annual molt (Fig. 2). Although the mean distance from haulouts to at-sea locations was slightly larger for subadults than adults, the distribution of all distances was very similar for both age classes (Fig. 3). Approximately 80% of distances were ≤ 15 km, and the percentage of distances greater than 50km was <1% for adults and <5% for subadults. These percentages do not necessarily indicate the amount of time seals spent at-sea at specific distances from haulouts, however, because seals likely spend more time at the water’s surface when near haulouts compared to when diving, resulting in more at-sea locations being received from seals near haulouts.

‘Foraging area’ size was significantly ($P=0.034$) different across months, with seals using larger areas in May and July, on either side of the peak pupping period in June when females are likely constrained in their foraging ability during the early lactation period (Fig. 4). Males may expand their range in July when females are more dispersed and in estrus after their pups are

weaned. 'Foraging area' size was significantly different ($P < 0.001$) among sub-regions in Southeast and Kodiak, with seals covering areas 3-times larger in regions adjacent to relatively large open water areas compared to seals on the inside of large bays. None of the 29 seals (both adult and sub-adults) tagged in the Kodiak Archipelago crossed the Shelikof Strait or traveled north to the Kenai Peninsula or Prince William Sound.

SUMMARY

During 1993-1997, harbor seal movement patterns and 'foraging area' size did not differ between Southeast Alaska and the Kodiak Archipelago, two areas that have exhibited distinctly different population dynamics over the last 20 years. Subadult seals consistently moved longer distances and used larger 'foraging areas' compared to adult seals. This result may be related to concurrent diving behavior, as adult females exhibited more focused diving (i.e., larger proportion of dives to one depth) than subadults in Kodiak and Prince William Sound. The large majority of at-sea locations were within 50 km of haulouts, as has been observed in other harbor seal populations outside of Alaska (Thompson 1993). Three-fold differences in 'foraging area' size were observed among sub-regions in both Kodiak and Southeast, a result that may be due to the availability of relatively large open water areas. The cumulative distance traveled among haulouts increased in May, and 'foraging area' size increased in May and July. These increases may not be associated with increased foraging, as preliminary analyses of the concurrent diving behavior suggest diving effort decreased from April through July. Future analyses will examine whether the spatial distribution of 'foraging areas' varied by age or across months, and if seals selected 'foraging areas' based on bathymetry.

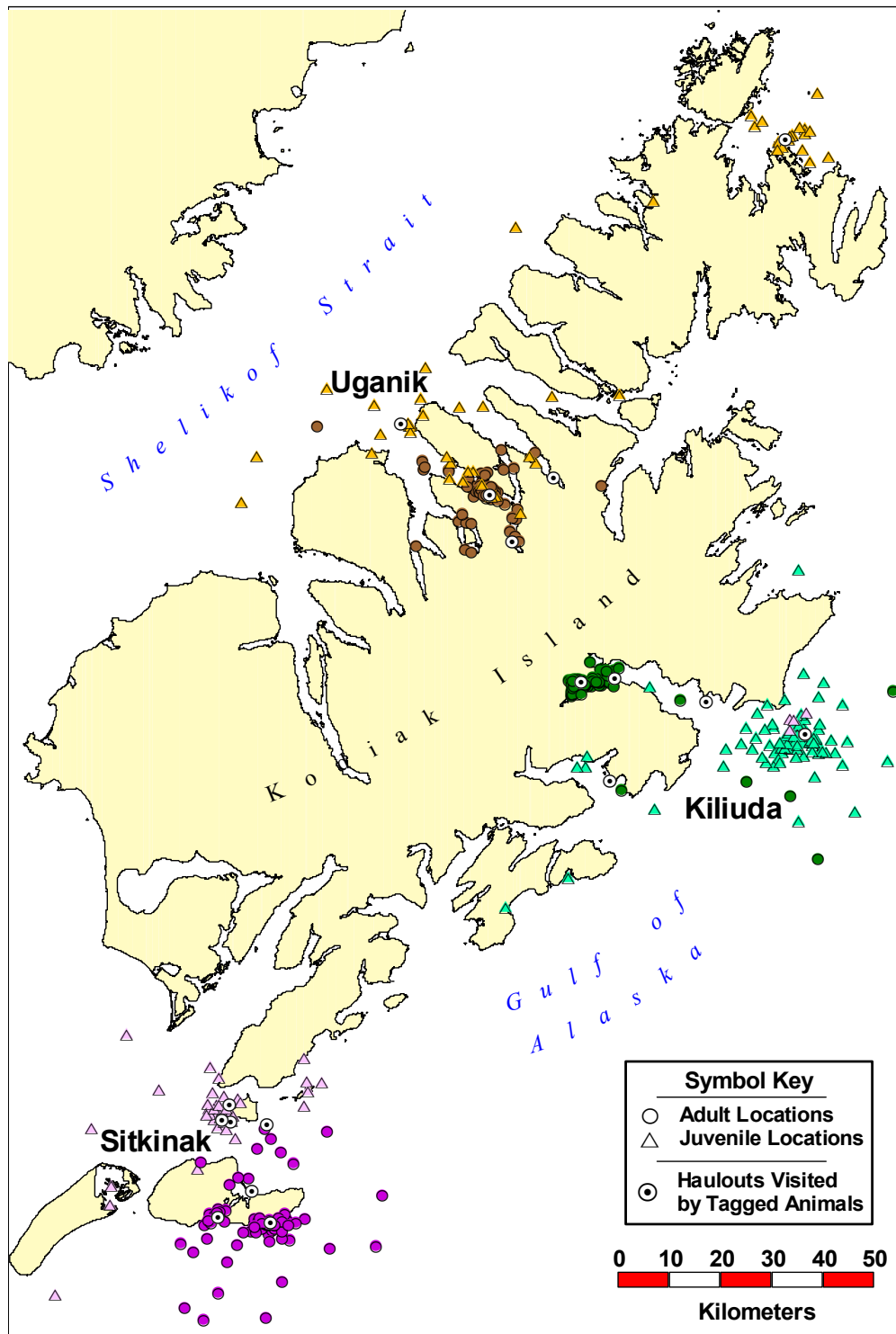
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Figure 1. Locations of one adult ('●' symbol) and one subadult ('▲' symbol) harbor seal tagged in each of the three areas studied in Kodiak (Uganik, Kiliuda, and Sitkinak). Subadult locations are more widely dispersed compared to the concentrated adult locations, and the subadults made extensive movements from Uganik to the northern end of Kodiak, and from Sitkinak to Kiliuda.



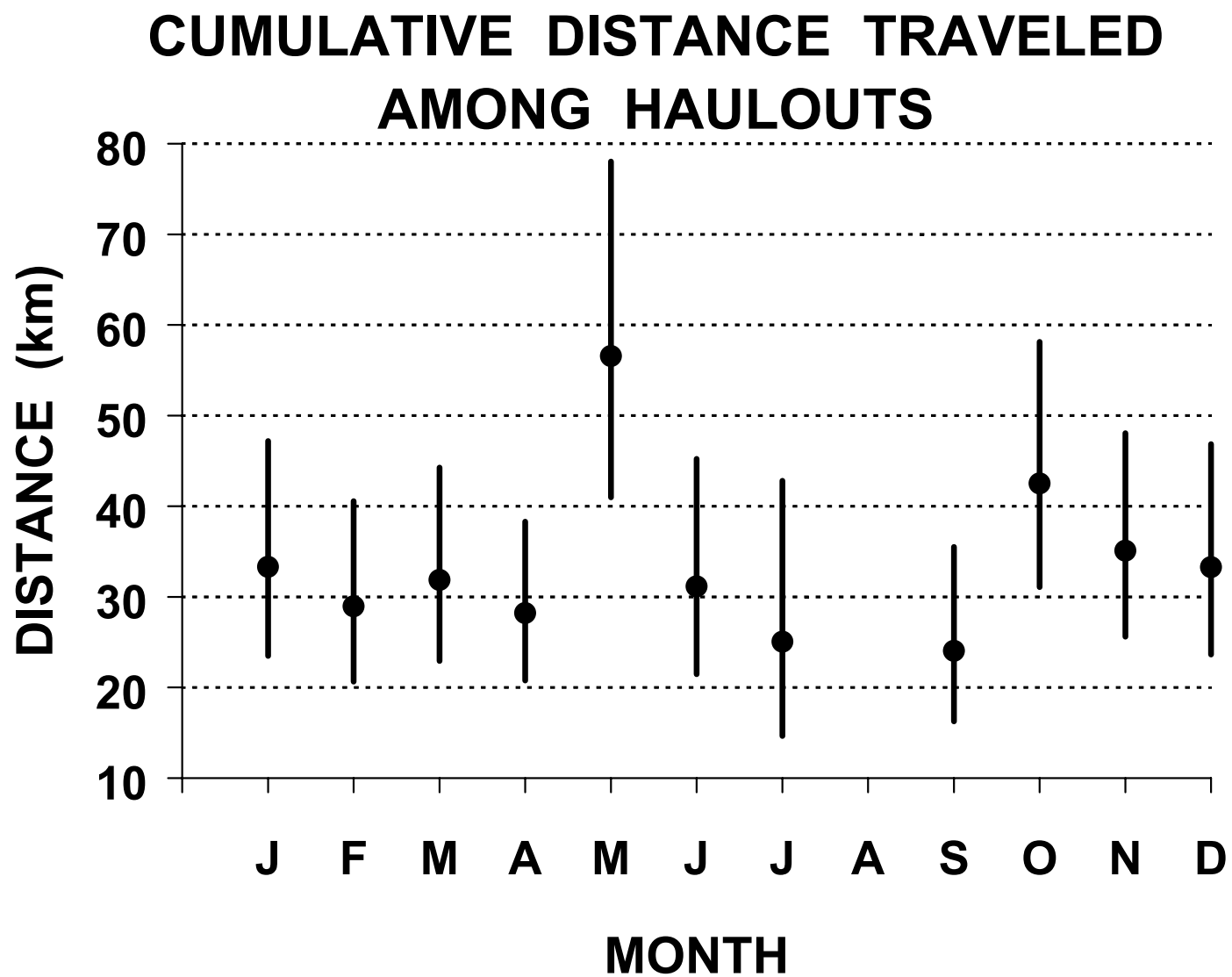


Figure 2. Cumulative monthly distance traveled among haulouts by harbor seals in the Kodiak Archipelago and Southeast Alaska regions, 1993-1997.

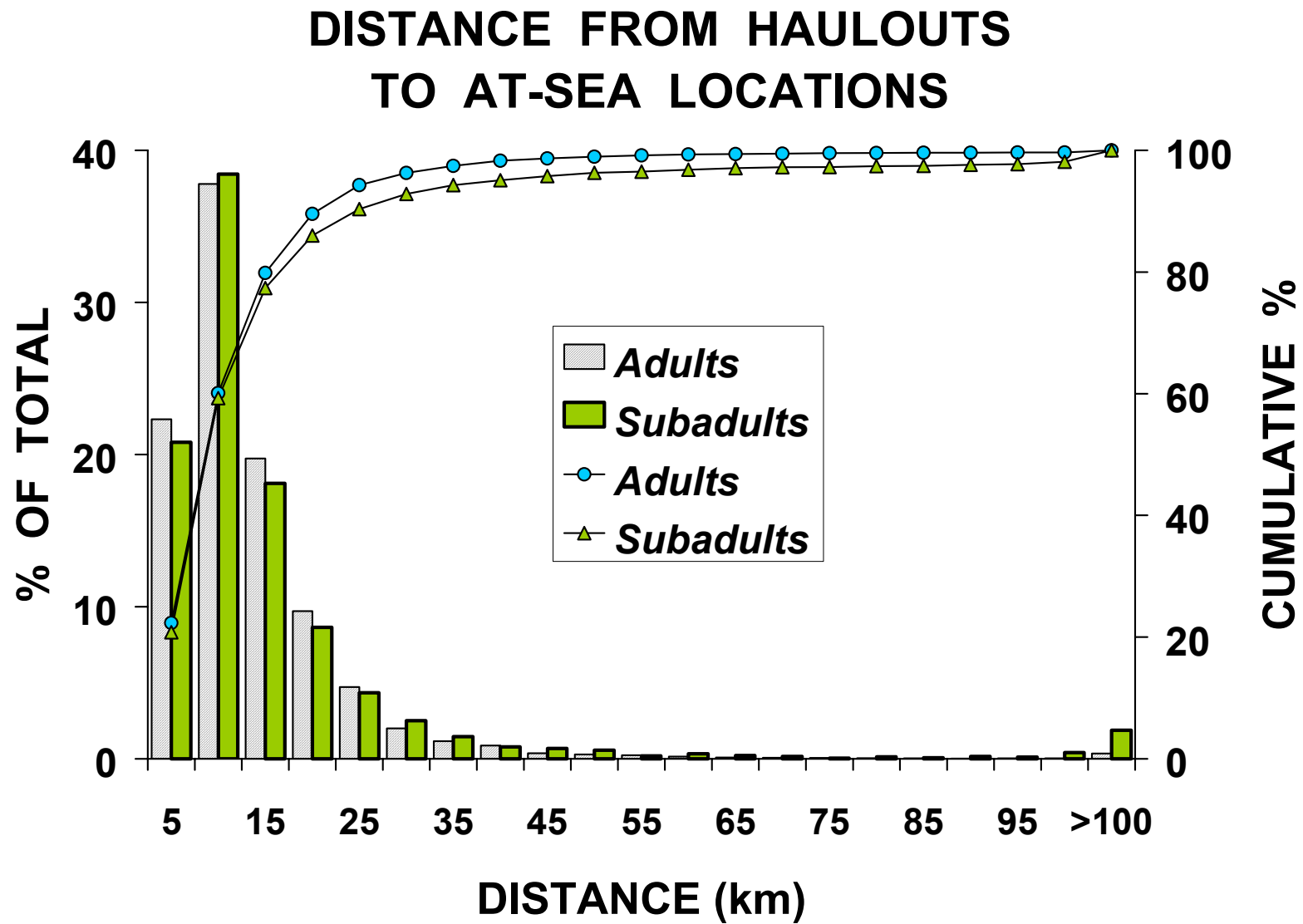


Figure 3. Frequency distribution and cumulative percentages of distances from haulouts to at-sea locations of harbor seals in the Kodiak Archipelago and Southeast Alaska regions, 1993-1997.

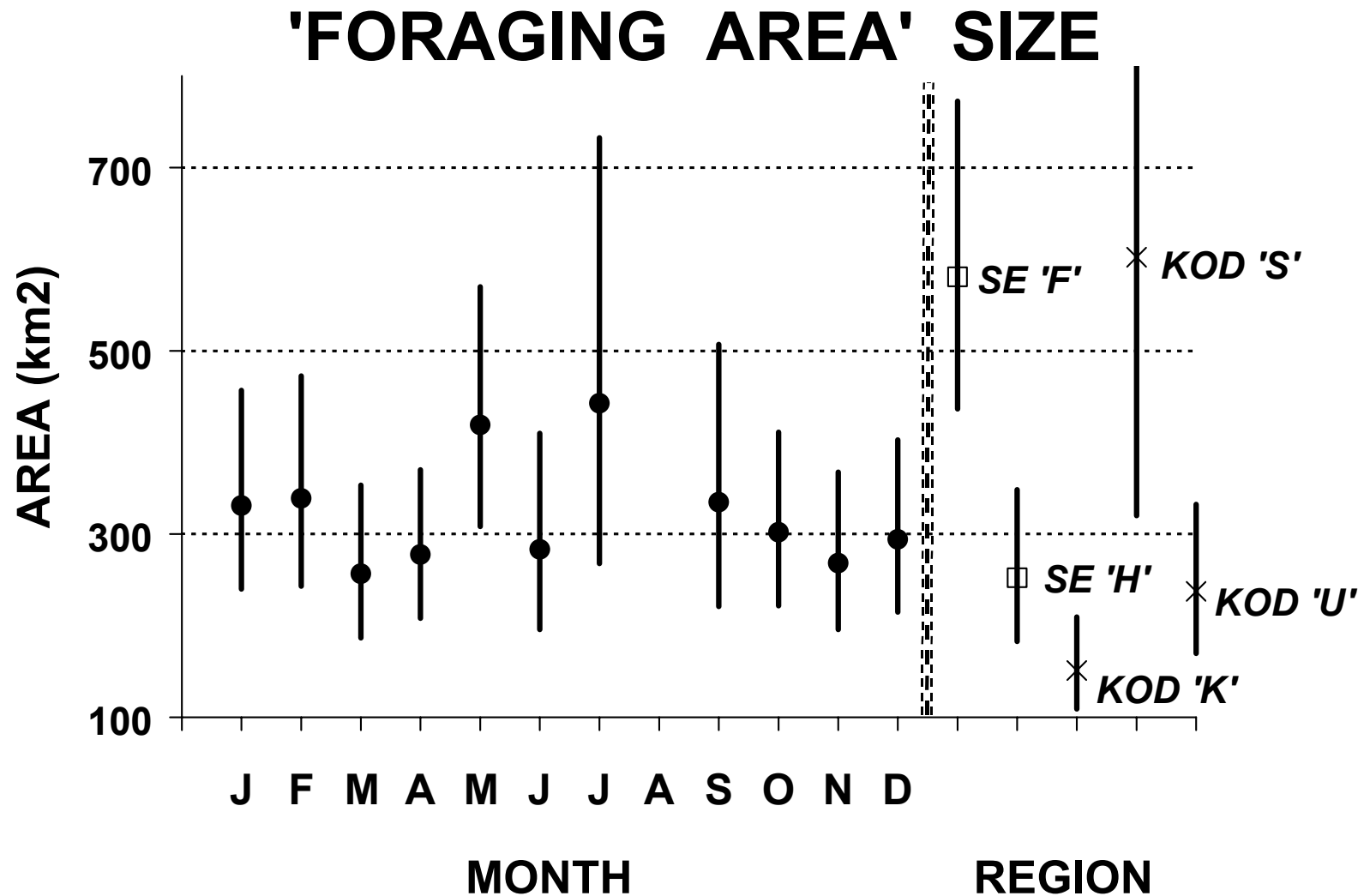


Figure 4. Monthly 'foraging area' size based on locations of harbor seals in the Kodiak Archipelago (KOD) and Southeast Alaska (SE) regions combined, 1993-1997. 'Foraging area' size was ~3-times larger where seals were adjacent to relatively large open water areas (Frederick Sound (SE 'F') and Sitkinak (KOD 'S')) compared to areas inside of large bays (Hoonah (SE 'H'), Kiliuda (KOD 'K'), and Uganik (KOD 'U')).